COMPLETELY BRITTLE FAILURE AND THE TECHNICAL COHESIVE STRENGTH

BY

DIMITRY MORKOVIN

B.S. (B.A.), University of Southern California, 1934
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SUMMARY OF THE THESIS

The principal purpose of this thesis is to state a number of methods for the determination of the technical cohesive strength of materials of engineering use. The methods are based on the interpretation of experimental work of a number of investigators, both in the United States and abroad.

Kuntze's approach to the problem is reviewed, the inherent difficulties in his method are discussed and the erroneous conclusions to which that method leads are illustrated by the results of the tests of Davidenkov and Shevandin.

On the basis of the work of Ioffe, Davidenkov, Shevandin, Kisin, Witman, Stepanov and others, the identity of the technical cohesive strength and of the ultimate strength of the material, in the case when the material fails in brittle manner (no matter whether the brittleness was caused by low temperature, impact, or triaxial tension), is pointed out and utilized in the determination of the technical cohesive strength. Experimental results are shown, which prove that when a metal is stressed in such a manner that plastic deformation is not prevented, the value of the virgin tech. cohesive strength (which the metal possessed before yielding) is changed in a continuous manner. The magnitude of the change depends on the amount of plastic deformation.

From the experimental results of a number of investigators it appears that the magnitude of the virgin technical cohesive strength of the materials tested by them is constant and independent of temperature and rate of straining. A hypothesis has been advanced that this is generally true. The value of the technical cohesive strength can be therefore obtained directly in some cases, merely by lowering the temperature, or increasing the rate of loading sufficiently to cause a completely brittle fracture, or both.

The justification is reviewed for Hollomon and Zener's proposition of equivalence of the influence (upon certain physical properties of materials) of a definite decrease in temperature to the influence of a definite increase in rate of

straining. Their proposition is checked on the basis of tests by Witman and Stepanov.

Experimental results of several investigators are shown, which exhibit a linear relation (1) between the logarithms of the values of yield points and the reciprocals of the temperatures of testing, (2) between the logarithms of the rate of straining and the reciprocals of the critical temperatures of brittleness, as well as (3) between the logarithms of the rate of straining and the reciprocals of the yield points (obtained at these rates of straining). It is shown how these relationships can be utilized indirectly for estimation of the value of the technical cohesive strength. Finally, a statement of the physical meaning of the concept of technical cohesive strength is given.

VITA

The author was born on May 11, 1911, in Prague, Czechoslovakia. After graduating in 1930 from 1st Czech State Real Gymnasium, Prague, he took a year's course (1930-31) in the Academy of Commerce, Prague, and attended the University of Prague in 1932-33. In the years 1933 to 1937, he attended the University of Southern California in Los Angeles, California. The year 1937-38, he spent on a fellowship in Mechanical Engineering at Rensselaer Polytechnic Institute, Troy, New York, and in 1938-39 he held the Sibley Fellowship in Mechanical Engineering at Cornell University, Ithaca, New York. During the first semester of 1939-40 he held a Graduate School Fellowship at the University of Illinois. From February 1940, to September 1941, he was Teaching Assistant in Mechanical Engineering at the Illinois Institute of Technology in Chicago, Illinois. From September 1941 to February 1942 he was a Graduate Research Assistant, from February 1942 to September 1943 an Instructor, and since September 1943 an Associate in Theoretical and Applied Mechanics at the University of Illinois, Urbana, Illinois. His professional experience, besides the research and teaching mentioned above, was three years' work in costs, systems and auditing with H. D. Campbell, C.P.A., Los Angeles, and consulting work in testing, design and stress analysis for several steel and machinery manufacturing companies.

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The titles of two publications of the author in collaboration with Professor H. F. Moore as the senior author are:

"Progress Report on the Effect of Size of Specimen on Fatigue Strength of Three Types of Steel," A.S.T.M. Proceedings, Vol. 42, 1942, pp. 145 and foll.

"Second Progress Report on the Effect of Size of Specimen on Fatigue Strength of Three Types of Steel," A.S.T.M. Proceedings, Vol. 43, 1943.

The following are the published discussions of the author:

"A Discussion of Plastic Flow as an Unstable Process" (discussion of paper by L. H. Donnell), Journal of Applied Mechanics, Transactions A.S.M.E., Vol 10, No. 1, March, 1943, pp. A-49 and foll.

"A Discussion of Plastic Flow and Rupture of Metals" (discussion connected with a paper by C. Zener and J. H. Hollomon), Transactions of the American Society for Metals, Vol. 33, 1944, pp. 221 and foll.